are at present affiliated with the university and located downtown. A new dental school building is about to be constructed.

THE sum of a quarter of a million dollars has been given by Mrs. Russell Sage to the Emma Willard School in Troy to found a department of domestic and industrial art to be known as the Russell Sage School of Practical Art. The new department will occupy the buildings recently vacated by the school on the completion of new buildings made possible by a gift of $1,000,000 from Mrs. Sage in 1907.

WE learn from *Nature* that Mr. Patrick Alexander, known by his pioneer work in aeronautics, has made over to the headmaster of the Imperial Service College, Windsor, the sum of £10,000 "for the furtherance of the education of boys of the Imperial Service College, *i. e.*, for the training of character and the development of knowledge." Mr. Alexander had given to the college an aero-laboratory and equipment about five years ago.

DR. IRVING E. MELHUS, formerly pathologist, office of cotton and truck diseases of the Bureau of Plant Industry, has assumed charge of the work in plant pathology in the Iowa State College.

DISCUSSION AND CORRESPONDENCE

GENETIC FACTORS AND ENZYME REACTION

IN spite of the great progress in the knowledge of facts in genetics the nature of genetic factors may well be regarded as unknown. Various theories have been proposed but only a few steps have been made to attack the problem experimentally. Those who approached it from the physiological-chemical side all seem to agree that the unit-factors are to be compared in some way to enzymes (Loeb, Robertson, Moore, Bateson, Riddle, etc.) or expressed more generally "that the hereditary factor . . . is a determiner for a given mass of certain ferments" (Loeb and Chamberlain, 1915).[1] At first sight there are not many ways visible of an experimental attack on this problem. One is described by Loeb and Chamberlain in the following words:

If we wish to carry this view (with which we sympathize) beyond the limit of a vague statement, we must either try to establish the nature of these compounds by the methods of the organic chemist, or we must use the methods of general or physical chemistry and try to find numerical relations by which we can identify the quantities of the reacting masses or the ratio in which they combine.

Some steps in this direction have been made by Loeb, Robertson and Ostwald, who tried to prove that the phenomena of growth may be understood as autocatalytic reactions; by Moore, who compared the velocity of development of a dominant character in homozygotes and heterozygotes; by Loeb and Chamberlain, who followed the more indirect way of proving the enzyme-reaction-like basis of a certain kind of fluctuating variability. It is further known that Miss Wheldale and Keeble are approaching the question by a direct study of the chemistry of plant pigments in hybrids of known constitution and quite recently a very interesting paper on hair-pigments in rodents has been published by Onslow.[2]

For some time I have had similar ideas in regard to these questions in connection with genetical experiments, approaching the subject from quite an unexpected side. It was not the intention to publish them before the entire work was finished. But as this will take some years longer and the subject is becoming meanwhile more popular, it might be advisable briefly to point out the ways in which I reached conclusions very similar to those of Loeb, etc.

The genetical reaction which is concerned primarily in my experiments is the pigmentation of the wings of moth. Its dependence upon genetic factors is well known and its chemical character—the amino-acid-oxydase reaction—is comparatively clear. In one set of experiments it could be shown how the quantity of pigment formation depends upon the quantitative combination of the hereditary factors.[3] The experiments were started in 1909 with the purpose of working out the genetics of melanism in moths. The experi-

1 *Jour. Exp. Zool.*, Vol. 19, 1915.

2 *Proc. R. Soc. S. B.*, Vol. 89, 1915.

3 Onslow's results are in the same line.

ments are so far finished, but details about them can not be published, because the records are not available just now. But one point can be stated in a general way. In my example, the nun (*Lymantria monacha*), all gradations are found between a white animal with the characteristic zig-zag bands and a completely black one. The breeding experiments show that these intermediates are to be explained by combinations of some, partly sex-linked, factors for pigmentation. The comparison of the wings shows that the pigmentation starts from certain points of outlet and spreads thence over the wing, gradually encroaching upon the white scales. Obviously there corresponds to every combination of factors, an enzyme reaction, definite in quantity. Of course, the same conclusion could already have been drawn from Nilsson-Ehle's well-known studies on oats. But the meaning of the reaction is so much more evident in the insect case.

The other way which led to similar conclusions in regard to the connection of hereditary factors with the quantity of enzyme reaction is quite an unexpected one. In some previous papers I have published the results of experiments in determination of sex in the gypsy moth and a report upon their further progress is now in press in the *Proc. Nat. Acad. Sc.* The point which concerns us here is the following. We have found a series of races of that moth, which differ in regard to the quantitative behavior of their sex-factors. We could prove that in a cross between these races the resulting sex with all the secondary sex-characters depends upon the quantitative relation of the male and female set of sex factors. In the hybrids all kinds of combinations of these two sets varying in their relative quantity, can be brought together. And the result is that every single step between the two sexes, for which I proposed the term intersexes, may be produced. The external characters of these animals now are determined in the following way: the female factorial set would produce entirely female characters, and in the same way the male set male characters. The real effect is a function of the arithmetical difference of these two. If this difference is in favor of one or both above a certain quantity, say $f - m > x$ or $m - f > z$, the pure sex is produced. But if the difference is beyond the constant minimum z and x, an intersex is produced. And the quantity of intersexuality increases proportionally to the decrease of the values $f - m$ or $m - f$. The effect of such a competition of two sets of factors, both influencing the same characters in different directions, is, of course, the same as if only one factor of a variable quantitative efficiency were present. And now we are able to draw a parallel between the quantities of the hereditary factor and the quantities of the observed enzymatic reaction causing the coloration of the wing.

In the colors and markings of the wings of these moths at least four factors or sets of factors are involved, as is shown by loss-mutations. The normal females have white wings with transverse zig-zag bands, and, in addition, a crescent-shaped spot and a point near it, resembling the Turkish emblem (crescent and star). In the males the same markings are present and also a diffuse color covering the entire wing and varying from light gray to almost black in different races. In a mutation, which appeared some years ago in my cultures, all ziz-zag bands, except the one near the edge of the wing, disappeared. The mutation is not sex-limited and independent of the general color of the wing as is shown by breeding tests. This general color is again subject to mutations in the male; and there appeared another mutation also in which the sex-linkage is broken and the female wings are colored. The following remarks apply only to the normal, general wing-pigmentation, linked with the male sex.

It is known through the work of Federley and others that this pigment flows out from the wing-veins spreading over the entire wing. And it might not be unsafe to say that it is the oxydase which diffuses from the hemolymph in the veins into the scales. If we now study the different grades of intersexuality produced in our experiments, we realize that every step leading from a normal female

through the different grades of intersexes to a male, or, vice versa, from a male to the female, is characterized by a definite intermediate step of wing-pigmentation. The color of the pigment is constant but its quantity is variable. And one sees at first sight that in the different intersexes a certain amount of pigment-producing oxydase, parallel to the quantitative behavior of the sex factors, is furnished by the veins, varying from 0 per cent. in the female to 100 per cent. in the male. If a male is becoming intersexual, white cunei appear between the veins on the brown wing. Their position and shape is irregular. The total unpigmented area in different animals of the same constitution, is, however, approximately the same. With growing intersexuality—as measured by all organs of the animal—the white spots become larger. And an inspection of the wings shows immediately that there must be present an amount of pigment or, more correctly, of oxydase, quantitatively fixed, and corresponding to the quantitative value of $m - f$; and that the given quantity (or concentration) flows out from the veins over the wing, producing brown scales, whereever it happens to come. With increasing inter-sexuality the phenomenon becomes still clearer. A stage is reached, where a white wing shows brown, pigmented venation; in some places a short stream of pigment seems to flow out from a vein. In still more advanced intersexual males, about two thirds transformed into females, only a few pigment spots and stripes are to be found on the wings along the veins. In the female intersexes the opposite process is observed, but the details are somewhat different, showing that these depend upon the genetically given wing structure, different in both sexes.

It seems that this case is an exceedingly clear one, demonstrating the principle ad oculos. But it may be of even greater significance. All organs different in the two sexes are affected in some way by the intersexuality. There is some hope that it might be possible to obtain by their analysis a similar insight in the process of growth, localization, symmetry, etc., involved in morphogenesis. But I think that it is already clear from the foregoing remarks, that we are right, when we reached, independently, the conclusion that the hereditary factor is a determiner for a given mass of ferments; and we can demonstrate it by the fact that a quantitative difference in the potency of hereditary factors causes a parallel, quantitatively different, enzyme production.

Richard Goldschmidt

Osborne Zoological Laboratory,
Yale University,
December, 1915

EARLY MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

To the Editor of Science: I am greatly interested in statistics published in your issue of December 3, in regard to the oldest members of the American Association for the Advancement of Science.

While my own membership dates only from 1870, my knowledge of and interest in the association far antedates that year. It seems almost certain that I have known the association by attending its meetings longer than any other person now living.

In 1851, Professor James H. Coffin, of Lafayette College, was a guest at our home in Albany and took me to the meeting in the old capitol.

Again in 1856 he was our guest. I was then a pupil at the Albany Academy, a building of historic interest as the place where Joseph Henry installed the first telegraph. One of the sessions of the association was held in the academy park, at which the Dudley Observatory was dedicated. I well remember the delight with which we watched Professor Agassiz draw figures with both hands while he talked; also the eloquent address of Edward Everett.

Wm. H. Hale

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SCIENTIFIC BOOKS

The Alligator and Its Allies. By Albert M. Reese, Ph.D., Professor of Zoology in West Virginia University. New York, G. P. Putnam's Sons, 1915. Pp. xi + 342. 62 figures and 28 plates.